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Two new species of *Phronia* Winnertz, 1864 (Diptera, Mycetophilidae) from Taita Hills, Kenya

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Abstract

Two new *Phronia* Winnertz, 1864 species—*P. hannarostiae* **sp. nov.** and *P. ristoi* **sp. nov.**—are described from Taita Hills in Kenya, representing the first named species of this genus in the African continent. The new species are morphologically similar to each other as well as to *P. flobertae* Matile – a species described from the Comoro Islands. These three species can be distinguished by details of the male terminalia, in particular by comparing the structures of the gonostyli. The new species are photographed and hand-drawn figures provided, and their taxonomy is discussed.

Keywords

Afrotropical region, fungus gnats, Kenya, new species, Sciaroidea, Taita Hills, taxonomy

Introduction

The genus *Phronia* Winnertz, 1864 was one of the first genera of fungus gnats (Diptera: Mycetophilidae) that was thoroughly studied in the 19th century. Namely, Henryk Dziedzicki (1889) published a monograph of European *Phronia* species including detailed descriptions of 51 species (some of them were later transferred to *Trichonta* Winnertz, 1864) supplemented by high quality figures, which are still invaluable in species delimitation today. Over the course of the next 130 years, a number of new species were described (e.g. Lundström 1906; Chandler 1992; Chandler and Ribeiro 1995;

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Chandler 2001; Jakovlev and Polevoi 2008; Kurina 2008; Ševčík 2009; Salmela and Kolcsár 2017) along with several meticulous synopses devoted to Finnish (Hackman 1970), Nearctic (Gagné 1975) and European species (Plassmann 1977). Moreover, as a part of the latest Mycetophilidae monographs, Zaitzev (2003) and Chandler (2022) reviewed the species in Russia and Britain, respectively. All in all, about 150 species are currently known from all zoogeographical regions except Antarctica, including three of them from fossils (Evenhuis 1994; Fungus Gnats Online Authors 2022). However, the majority of the species have been discovered from the Palaearctic and Nearctic Regions, whereas only two are known from the Neotropical Region (Oliveira and Amorim 2014) and one from both Oriental and Australasian Regions (Bechev 2000). In the Afrotropical Region, four species of *Phronia* have so far been described, one from Seychelles and three from the Comoro Islands (Matile 1978). Matile (1978) additionally mentioned an undescribed species from Malawi and provided figures of male terminalia of all described Afrotropical species. Moreover, Søli (2017) noted that there are undescribed species known from Madagascar, South Africa, Tanzania and Uganda.

As a member of the tribe Mycetophilini, the genus *Phronia* has anepisternum with strong bristles, whereas within the tribe, the distinguishing characters include bare anepimeron, short cubital fork, subcostal vein ending free and the costal vein extending at most very slightly beyond apex of R_{4+5} (e.g. Søli et al. 2000). As usual for the majority of fungus gnats, the species-specific characters appear mostly in the structure of the male terminalia.

The current paper aims to describe two new species from Kenya, representing the first named *Phronia* species from the continental Africa.

Material and methods

The material was collected from Taita Hills in southern Kenya. The slopes of Taita Hills were formerly covered by moist montane forest of which only fragments are left, but these areas still accommodate a considerable diversity of species including endemic taxa (cf. Rosti et al. 2022).

The material was collected by handpicking specimens from a ground level rock cavity (Fig. 1) surrounded by tropical deciduous forest (Fig. 2) and preserved initially on a cotton-layer in an envelope. These specimens represent the only Mycetophilidae collected at this site. In the laboratory, all specimens were first kept in a high humidity relaxing chamber and when the specimens became pliable they were pinned and photographed. Thereafter, terminalia were detached from the abdomen and treated in a solution of hot KOH for maceration. The remaining chitinous parts were washed with distilled water, neutralized in acetic acid and transferred into glycerine. After examination, terminalia were stored in glycerine in a small plastic microvial together with the specimen.

The digital images of general habitus and terminalia were combined using the software LAS V.4.1.0. from multiple gradually focused images taken by a Leica DFC 450 camera attached to a stereomicroscope Leica 205C (see also Kurina et al. 2017). Topaz

Figure 1. The specimens were collected from a ground level rock cavity in Ngangao indigenous forest. Photo by H Rosti.

Figure 2. Ms. Hanna Rosti on fieldwork in tropical deciduous forest that surrounds the collecting locality in Taita Hills. The patronymic name *P. hannarostiae* honours her substantial contribution to make collecting of the fungus gnat material of this paper possible. Photo by A Pototski.

Sharpen Al v3.2.2 software was implemented to enhance the quality of the images. Black and white figures of the terminalia were prepared using a U-DA drawing tube attached to a compound microscope Olympus CX31. Adobe Photoshop CS5 was used for editing the figures and compiling the plates. The morphological terminology other than male terminalia follows that of Søli (2017). The terminology of male terminalia is used in accordance with Kjærandsen et al. (in press) and is explained also in Figs 4, 6, 7. The material is deposited in the Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences [former Institute of Zoology and Botany], Tartu, Estonia (**IZBE**).

Taxonomy

***Phronia hannarostiae* sp. nov.**
https://zoobank.org/BC67E7A9-C34A-48D0-AA50-6017CACFC40C
Figs 3A, 4A–F, 6B, 7B

Diagnosis. *Phronia hannarostiae* sp. nov. is closest morphologically to *P. flobertae* Matile, 1978 and *P. ristoi* sp. nov. but differs in characters of the male terminalia: gonocoxites anteroventrally with wide shallow incision; distal lobe of the ventral branch of the gonostylus elongated and stout; medial lobe of the ventral branch of the gonostylus sub-rounded with a strong long spine at dorsal margin medially; internal branch of the gonostylus bipartite, with ventral lobe apically widening, having combs of spines along posterior and dorsal margins, with dorsal lobe conical, having marginal lamellae; anterior branch of the gonostylus subrectangular, posteriorly somewhat widening, with four long setae subapically; aedeagal guides wide, narrower basally, rounded.

Etymology. The species is named after Ms. Hanna Rosti (Helsinki, Finland), a PhD student of the University of Helsinki. Her study project includes research and conservation of nocturnal mammals of Taita Hills. She generously assisted and guided Mr. Risto Haverinen (Vantaa, Finland) and the junior author, collectors of the material, around the named area.

Description. Male. Body length 3.1–3.2 mm (n = 4). **Coloration.** Head with vertex and frons brown, face and clypeus dark yellow, mouthparts yellow except palpus dark brown. Scape, pedicel and base of first flagellomere yellow, rest of flagellum brown. Thorax with scutum dull-yellow, having three longitudinal dull-brown strips, medial tapering posteriorly, ending before posterior margin; scutellum anteriorly brown, posteriorly yellowish to light brown; anepisternum, laterotergite and medial part of mediotergite brown, other thoracic lateral parts yellow. Thoracic setae brown. Wing hyaline, unmarked with slight yellowish tinge. Halter with stem yellow and knob brown. Legs yellow, hind coxa with lateral elongated brown macula, mid coxa with brown macula apically, hind femur entirely brown at apical fifth and brown dorsally at apical half, all tibiae with brown apical band, and tarsi yellow but seem darker because of dense brown setae. All setae on legs brown, tibial spurs brown. Abdomen brown, first 3–4 segments with large yellow anterolateral areas. Abdominal vestiture

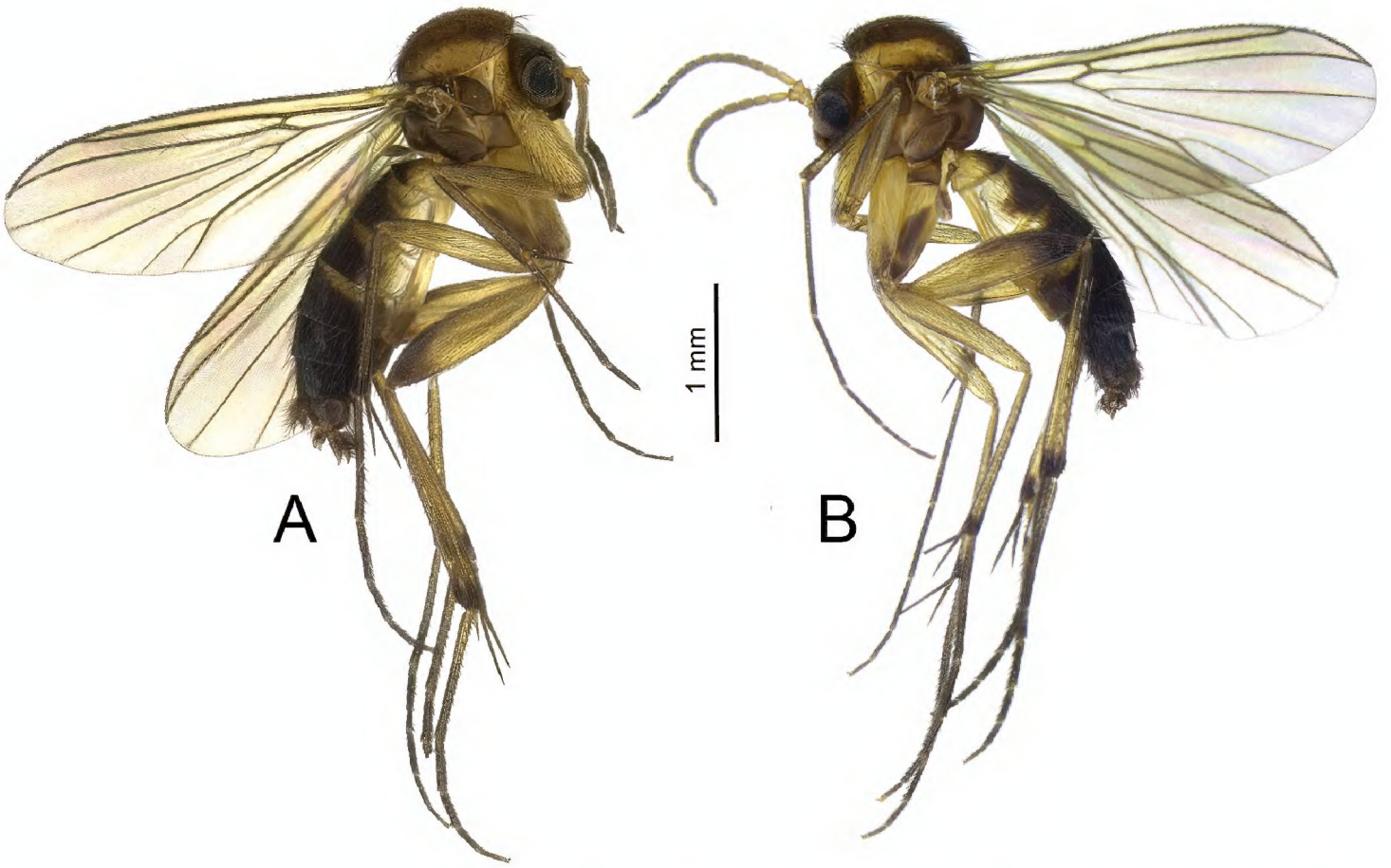

Figure 3. General habitus of Afrotropical *Phronia* species, lateral view **A** *P. hannarostiae* sp. nov. **B** *P. ristoi* sp. nov.

brown. Terminalia dark yellow. ***Head.*** Ocelli two, touching eye margins. Frontal furrow complete. Clypeus rectangular. Fourth flagellar segment about as long as wide, apical flagellar segment 2.2 times as long as wide basally. Flagellar segments with dense whitish setae about one third of segments' width. ***Thorax.*** Scutum covered with setae, marginal setae stronger, two prominent prescutellar setae extending well over scutellum posteriorly. Scutellum with four strong marginal setae. Antepronotum with 4–5 strong and several weaker setae. Proepisternum with three strong and some weaker setae. Anepisternum with four strong setae at hind margin and several weak setae over surface. Katepisternum and anepimeron non-setose. Laterotergite setose with setae longer towards hind margin. Mediotergite non-setose. ***Wing.*** Length 2.88–3.00 mm, length to width 2.77–2.82. *Sc*, *bm-m*, *m-stem* and *CuP* non-setose, all other veins setose. *C* extending very slightly beyond apex of R_{4+5}. Length of *Sc* measured from *h* 0.47 of *r-stem*. *r-m* about as long as *m-stem*. Posterior fork begins well beyond furcation of anterior fork, at the level of basal third of anterior fork, ratio of M_2 to M_4 2.7. ***Legs.*** Ratio of femur to tibia for fore, mid and hind legs: 1.11–1.29; 0.95–1.03; 0.84–0.93. Ratio of tibia to basitarsus for fore, mid and hind legs: 1.00–1.13; 1.30–1.48; 1.67–1.77. Fore tibia with a spur 2.25–2.57 times of tibial maximum width. Mid tibia with anterior spur 3.11–3.25 times and posterior spur 3.89–4.25 times of tibial maximum width. Hind tibia with anterior spur 2.55–3.22 times and posterior spur 3.27–3.89 times of tibial maximum width. ***Terminalia*** (Figs 4A–F, 6B, 7B). Tergite 9 posteriorly rounded, with non-regular row of sub-marginal setae of different length, anteriorly with large U-shaped incision. Cerci long ovate, posteriorly blunt.

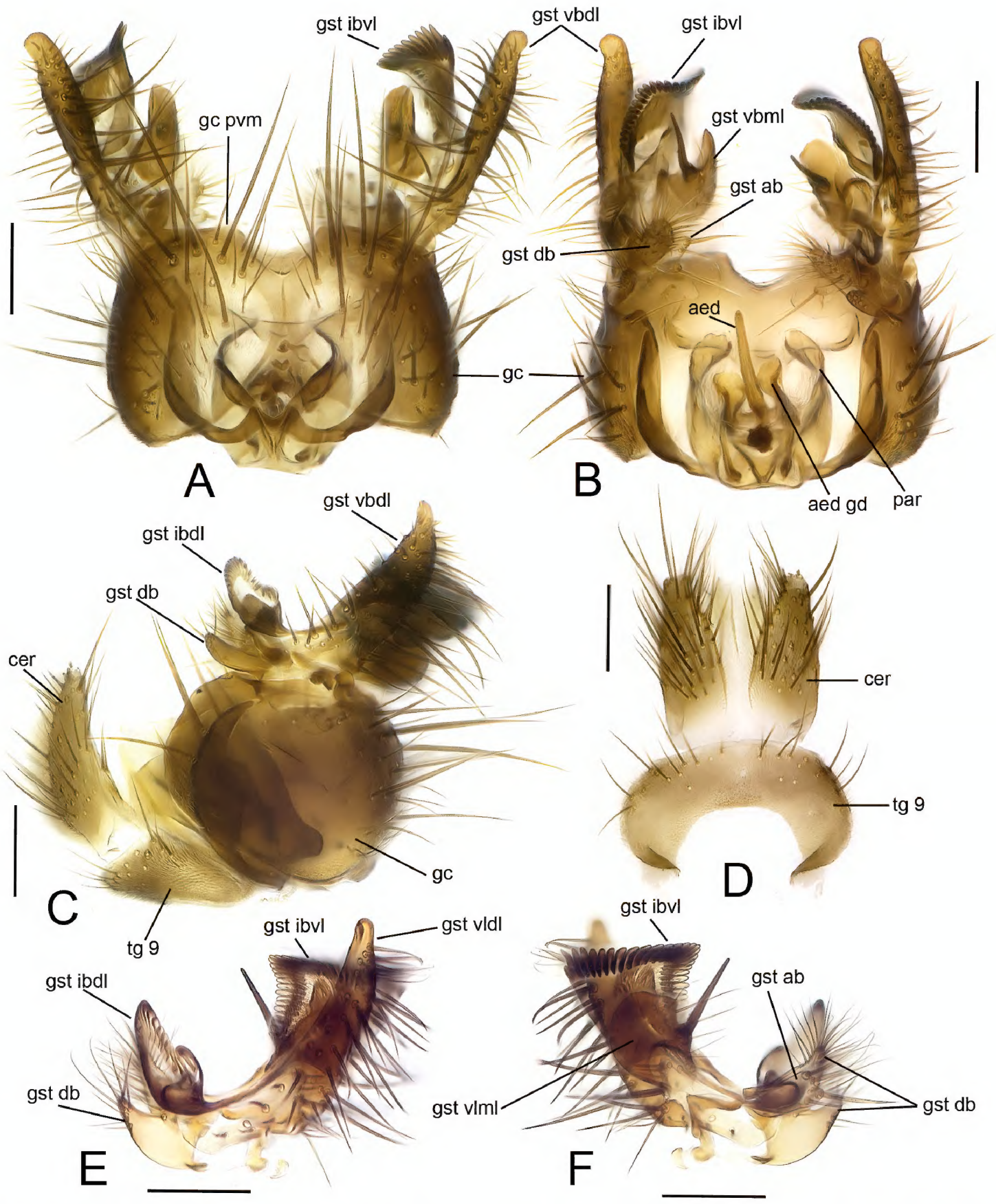

Figure 4. *Phronia hannarostiae* sp. nov., male terminalia **A** terminalia, ventral view **B** terminalia, dorsal view with cerci detached **C** terminalia, lateral view **D** cerci and tergite IX **E** gonostylus, lateral view **F** gonostylus, internal view. Abbreviations: aed = aedeagus, aed gd = aedeagal guide, cer = cercus, gc = gonocoxite, gc pvm = posteroventral margin of gonocoxite, gst ab = anterior branch of gonostylus, gst db = dorsal branch of gonostylus, gst ibdl = dorsal lobe of internal branch of gonostylus, gst ibvl = ventral lobe of internal branch of gonostylus, gst vbdl = distal lobe of ventral branch of gonostylus, gst vbml = medial lobe of ventral branch of gonostylus, par = paramere, tg 9 = tergite IX. Scale bars: 0.1 mm.

Gonocoxites fused, closed ventrally and open dorsally; anteroventrally with wide, shallow incision. Posteroventral margin of gonocoxites with medial incision, supplied by a dorsal fringe. Gonocoxites setose with setae erect, somewhat longer on posterior half,

deviating from other setosity of gonocoxites. Ventral branch of gonostylus with setose distal lobe, elongated and tapering in lateral view, posteriorly blunt and non-setose; setose medial lobe subrounded, with excavation at dorsal margin posteriorly and with a stout spine at dorsal margin medially. Internal branch of gonostylus formed of ventral and dorsal lobes; ventral lobe large, posteriorly widening, discernible partly between distal and medial lobe of ventral branch, with combs of spines along posterior and dorsal margin; dorsal lobe cone-shaped with lamellae along margins. Dorsal branch of gonostylus formed from two conical, posteriorly setose lobes. Anterior branch of gonostylus subrectangular, posteriorly slightly widening, with four subapical strong setae. Aedeagus digitate. Aedeagal guides apically widening, rounded. Parameres large, somewhat convoluted, not extending over aedeagus apically.

Female. Unknown.

Type material. ***Holotype.*** Kenya • ♂; Taita-Taveta County, Taita Hills, Ngangao indigenous forest; 3.3642°S, 38.3410°E alt. 1930 m; 4 February 2022; A. Pototski & R. Haverinen leg.; hand-picked (pinned, terminalia in glycerin, IZBE0228825). ***Paratypes.*** Kenya • 3 ♂♂, same data as for holotype (pinned, terminalia in glycerin, IZBE0228826, IZBE0228827, IZBE0228828).

Comments. Matile provided figures of male terminalia of all described Afrotropical *Phronia* species from ventral view (Matile 1978: figs 59–62) that regrettably do not describe all details of the gonostyli. However, the distal lobes of the ventral branch of the gonostylus and ventromedial margin of the gonocoxites have been provided in necessary details to allow an unambiguous delimitation of the species. *Phronia hannarostiae* sp. nov. shares the general outline of the gonostylus with *P. ristoi* sp. nov. but can be distinguished by (1) distal lobe of the ventral branch of the gonostylus stout, posteriorly blunt with subequal setae along the surface (slender, posteriorly tapering and bent, with aggregation of very long setae anteroventrally in *P. ristoi*), (2) medial lobe of the ventral branch of the gonostylus subrounded with a stout spine at dorsal margin medially (thumb-shaped, with a small hump at dorsal margin medially, with a sabre-like spine subapically in *P. ristoi*) and (3) internal branch of the gonostylus with ventral lobe large, posteriorly widening, with combs of spines along posterior and dorsal margin (large, conical, with comb of lamellae along dorsal margin in *P. ristoi*). Moreover, *P. hannarostiae* has (1) cerci long, ovate, posteriorly blunt (tapering posteriorly, with a mesial excavation in *P. ristoi*), (2) aedeagal guides apically widening, rounded (digitiform, apically pointed in *P. ristoi*) and (3) parameres large, somewhat convoluted, not extending over aedeagus apically (large, extending over aedeagus apically in *P. ristoi*).

Phronia ristoi **sp. nov.**

https://zoobank.org/409BD520-67BF-4B36-8AAA-070668D788B6
Figs 3B, 5A–F, 6A, 7A

Diagnosis. *Phronia ristoi* sp. nov. is closest to *P. flobertae* Matile, 1978 and *P. hannarostiae* sp. nov. but differs in characters of the male terminalia: gonocoxites anteroventrally with shallow U-shaped incision; distal lobe of the ventral branch of the gonostylus

elongated, tapering, apically bent; medial lobe of the ventral branch of the gonostylus thumb-like, with a strong long sabre-like spine subapically; internal branch of the gonostylus bipartite, with ventral lobe conical, having a comb of lamellae along dorsal margin, with dorsal lobe bipartite, having marginal lamellae; anterior branch of the gonostylus posteriorly rounded, with 3–4 long setae subapically; aedeagal guides digitiform, apically pointed.

Etymology. The species is named in honor of Mr. Risto Haverinen (Vantaa, Finland), a Finnish entomologist working mainly on macrolepidoptera. He was one of the collectors of the material of both species described in this paper and, additionally, contributed greatly towards successful fieldwork in Kenya.

Description. Male. Body length 2.9–3.0 mm (n = 2). **Coloration.** Head with vertex and frons dark brown, face and clypeus dark yellow to light brown, mouthparts yellow except palpus dark brown. Scape, pedicel and base of first flagellomere yellow, rest of flagellum brown.

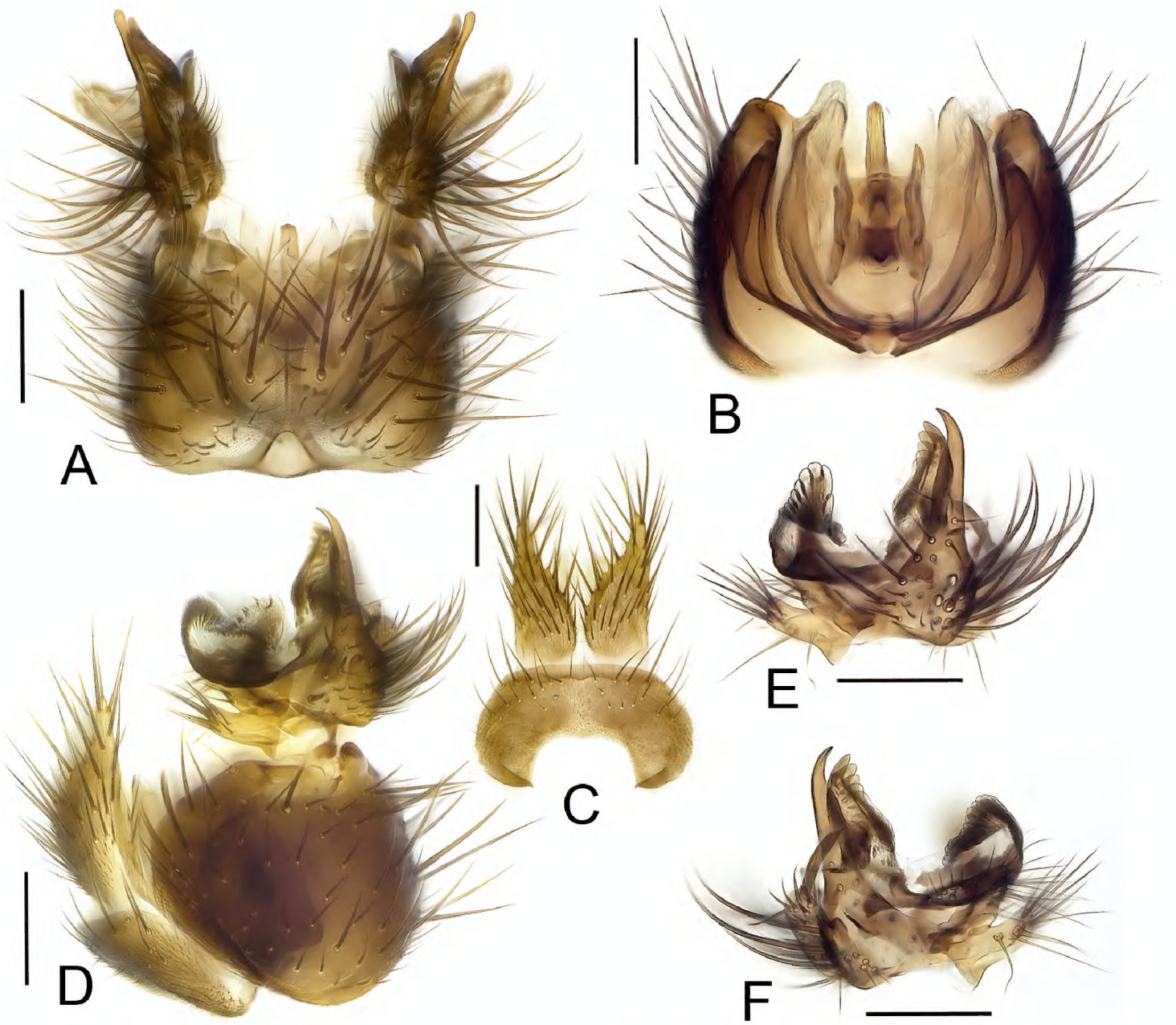

Figure 5. *Phronia ristoi* sp. nov., male terminalia **A** terminalia, ventral view **B** terminalia, dorsal view with gonostyli and cerci detached **C** terminalia, lateral view **D** cerci and tergite IX **E** gonostylus, lateral view **F** gonostylus, internal view. Scale bars: 0.1 mm.

Thorax with scutum dull-yellow, having three anteriorly fused longitudinal dull-brown strips, medial tapering posteriorly, ending before posterior margin; scutellum dull brown; antepronotum and proepisternum yellow, other thoracic lateral parts dull brown, posterior margin of laterotergite darker. Thoracic setae brown. Wing hyaline, unmarked with slight yellowish tinge. Halter with stem yellow and knob brown. Legs yellow, hind coxa with lateral elongated brown macula, hind femur entirely brown at apical fifth and brown dorsally at apical half, all tibiae with brown apical band, and tarsi yellow but seem darker because of dense brown setae. All setae on legs brown, tibial spurs brown. Abdomen brown, first 3–4 segments with yellow anterolateral areas. Abdominal vestiture brown. Terminalia dark yellow to brown. ***Head.*** Ocelli two, touching eye margins. Frontal furrow complete. Clypeus rectangular. Fourth flagellar segment about 1.2 times as long as wide, apical flagellar segment 2.1 times as long as wide basally. Flagellar segments with dense whitish setae about one third of segments' width. ***Thorax.*** Scutum covered with setae, marginal setae stronger, two prominent prescutellar setae extending well over scutellum posteriorly. Scutellum with four strong marginal setae. Antepronotum with four strong and several weaker setae. Proepisternum with three strong and some weaker setae. Anepisternum with 3–4 strong setae at hind margin and several weak setae over surface. Katepisternum and anepimeron non-setose. Laterotergite setose with setae longer towards hind margin. Mediotergite non-setose. ***Wing.*** Length 2.67–2.79 mm, length to width 2.53–2.65. *Sc*, *bm-m*, *m-stem* and *CuP* non-setose, all other veins setose. *C* extending very slightly beyond apex of R_{4+5}. Length of *Sc* measured from *h* 0.50 of *r-stem*. *r-m* about 0.75 times as long as *m-stem*. Posterior fork begins well beyond furcation of anterior fork, at the level of basal third of anterior fork, ratio of M_2 to M_4 2.4. ***Legs.*** Ratio of femur to tibia for fore, mid and hind legs: 0.96–1.00; 0.91–0.94; 0.87–0.91. Ratio of tibia to basitarsus for fore, mid and hind legs: 1.00–1.04; 1.43–1.50; 1.73–1.80. Fore tibia with a spur 2.67 times of tibial maximum width. Mid tibia with anterior spur 3.00–3.57 times and posterior spur 4.29 times of tibial maximum width. Hind tibia with anterior spur 2.50–2.70 times and posterior spur 3.10–3.50 times of tibial maximum width. ***Terminalia*** (Figs 5A–F, 6A, 7A). Tergite 9 posteriorly rounded, with non-regular row of sub-marginal setae of different length, anteriorly with large U-shaped incision. Cerci long ovate, tapering posteriorly, with well discernible excavation mesially. Gonocoxites fused, closed ventrally and open dorsally; anteroventrally with shallow U-shaped incision. Posteroventral margin of gonocoxites medially membranous with a shallow incision. Gonocoxites setose with erect setae of sub-equal length. Ventral branch of gonostylus with setose distal lobe, anteriorly shoe-shaped, anteroventral part with an aggregation of long curved setae, posterior part non-setose, slightly bent; setose medial lobe thumb-shaped, with a small hump at dorsal margin medially and with a sabre-like spine subapically. Internal branch of gonostylus formed of ventral and dorsal lobes; ventral lobe large, conical, discernible partly between distal and medial lobe of ventral branch, with comb of lamellae along dorsal margin; dorsal lobe bipartite with lamellae along margins. Dorsal branch of gonostylus formed from two conical setose lobes. Anterior branch of gonostylus thumb-shaped, with 3–4 subapical long setae. Aedeagus digitate. Aedeagal guides digitiform, apically pointed. Parameres large, extending over aedeagus apically.

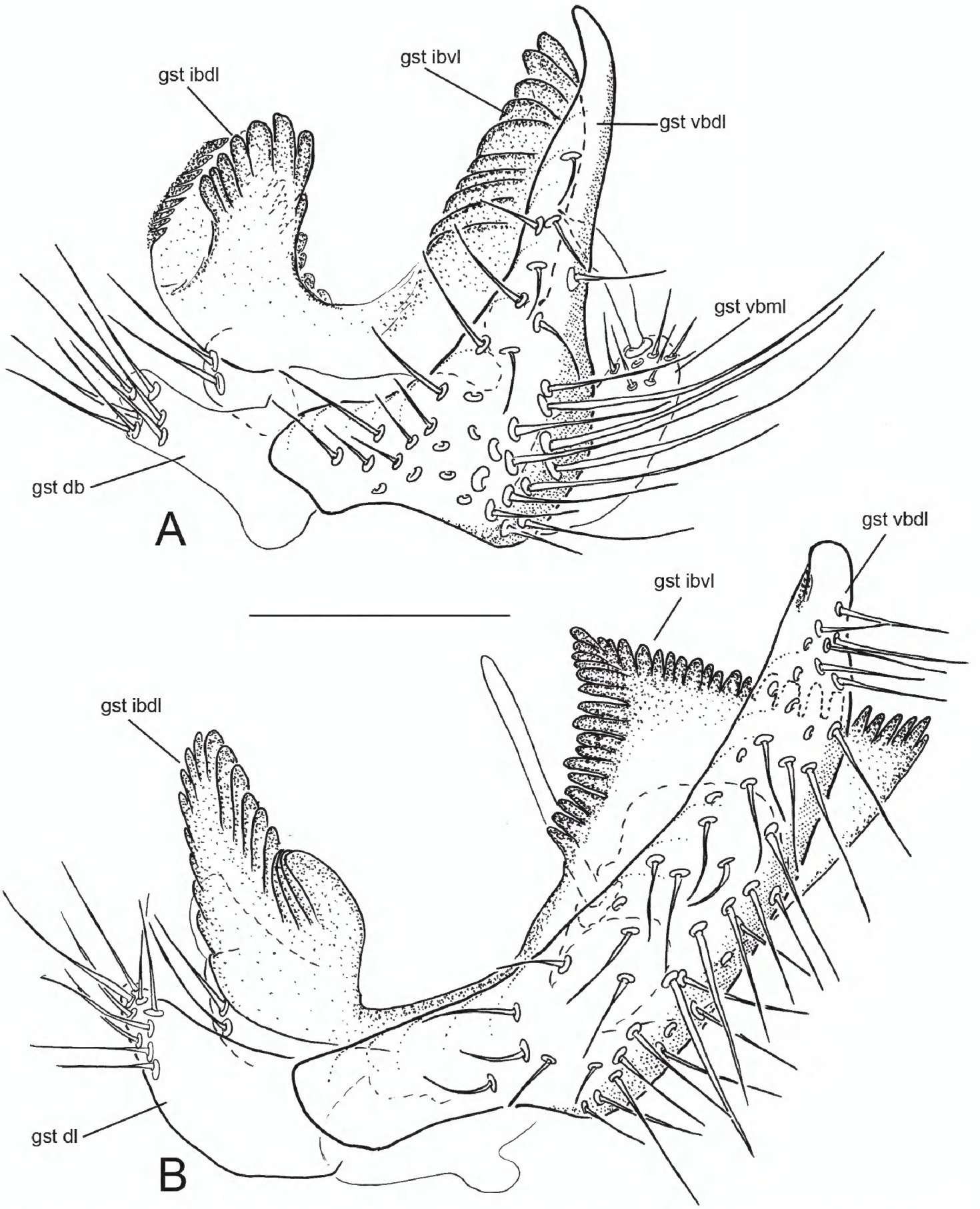

Figure 6. Gonostylus, lateral view **A** *Phronia ristoi* sp. nov. **B** *Phronia hannarostiae* sp. nov. For abbreviations see Fig. 4. Scale bar: 0.1 mm.

Female. Unknown.

Type material. ***Holotype.*** Kenya • ♂; Taita-Taveta County, Taita Hills, Ngangao indigenous forest; 3.3642°S, 38.3410°E; alt. 1930 m; 4 February 2022; A. Pototski & R. Haverinen leg.; hand-picked (pinned, terminalia in glycerin, IZBE0228829). ***Paratypes.*** Kenya • ♂, same data as for holotype (pinned, terminalia in glycerin, IZBE0228830).

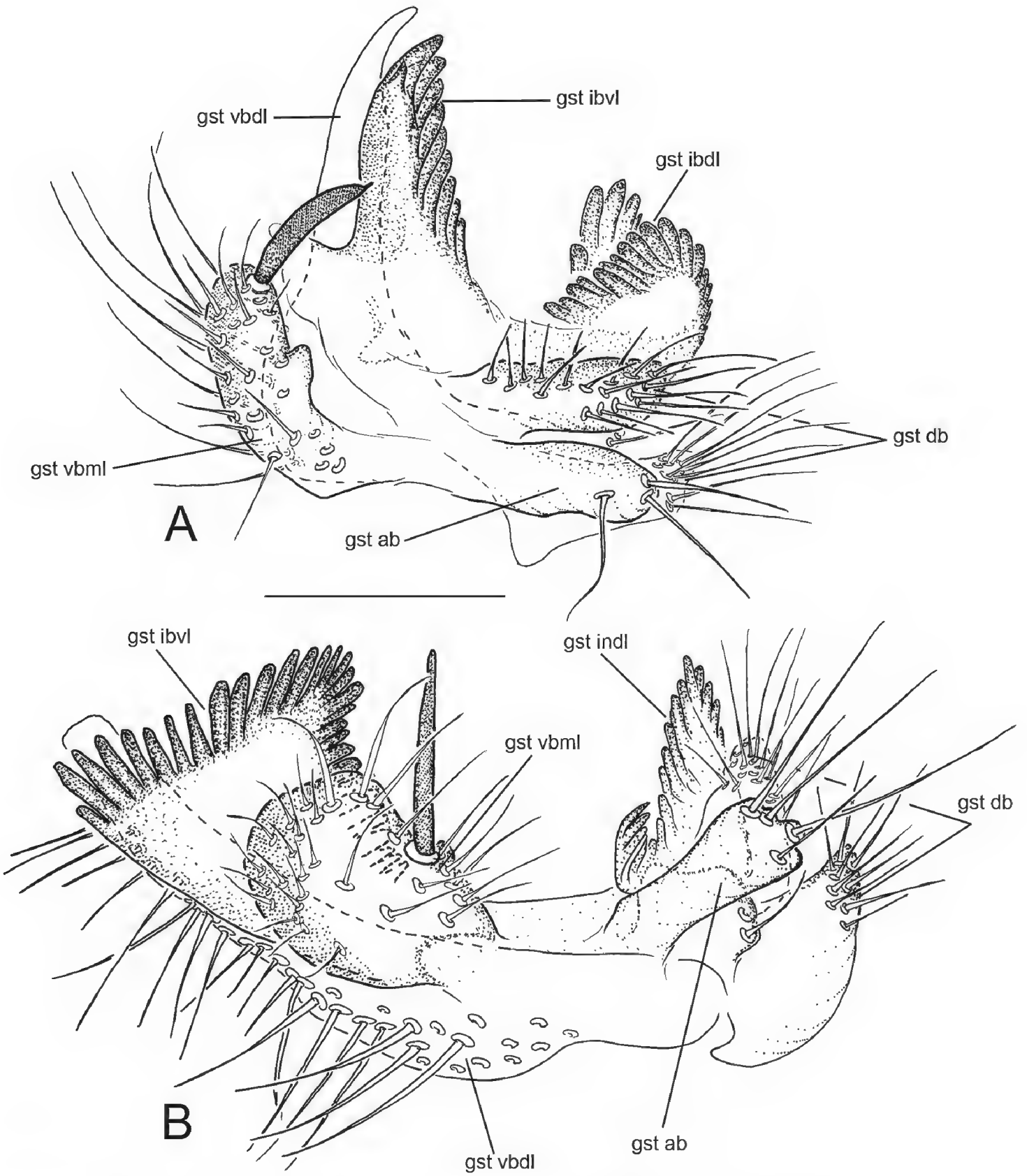

Figure 7. Gonostylus, internal view **A** *Phronia ristoi* sp. nov. **B** *Phronia hannarostiae* sp. nov. For abbreviations see Fig. 4. Scale bar: 0.1 mm.

Comments. For distinguishing *P. ristoi* sp. nov. from *P. hannarostiae* sp. nov. see comments under the latter. *Phronia ristoi* resembles also *P. flobertae* Matile, 1978 as both species have distal lobe of ventral branch of the gonostylus evenly tapering posteriorly. However, *P. ristoi* has (1) the medial lobe of ventral branch of the gonostylus with strong sabre-like subapical spine, well discernible also from ventral view (without any spine in *P. flobertae*) and (2) the ventral lobe of internal branch of the gonostylus conical, in subequal length with the distal lobe of the ventral branch (subrectangular, about half length of the distal lobe of the ventral branch in *P. flobertae*).

Discussion

Afrotropical fungus gnats (Diptera: Mycetophilidae) are rather superficially studied, with only about 10% of the real diversity known (Kirk-Spriggs and Stuckenberg 2009). Although a number of additional species have been described during the past decade (e.g. Hippa and Kurina 2012; Hippa et al. 2019; Magnussen et al. 2018; Kurina 2020; Lindemann et al. 2021), the family remains one of the least studied among Diptera in the Afrotropical region. From Kenya, only 12 species of Mycetophilidae are known to date (Matile 1980, 1992; Magnussen et al. 2018; Lindemann et al. 2021).

Taita Hills in Kenya constitute the most northeastern massive of the Eastern Arc Mountains (EAM) and the only section of this chain outside Tanzania. The EAM are known as the smallest and most fragmented biodiversity hotspots in the world (Myers et al. 2000). About ten million years ago, the savanna changed into a dominating biome in lowland, whereas the mountain ranges covered with moist tropical forest survived as isolated "islands" with a high degree of endemic species (Schabel 2006; World Wildlife Fund 2014). In terms of fungus gnats, several supposedly endemic species have been described from EAM earlier, particularly from Usambara Mountains in Tanzania (Søli 1993, 1997; Kjærandsen 1994; Magnussen et al. 2018). The described two *Phronia* species represent the first named species of this genus from continental Africa as well as the first fungus gnats from Taita Hills in Kenya.

Acknowledgements

We are much obliged to Ms. Hanna Rosti (Helsinki, Finland) and Mr. Risto Haverinen (Vantaa, Finland), who participated in fieldwork in Kenya, including collecting the specimens for this study. We are also thankful to Mr. Benson Mwakachola Lombo, a nature guide in the Taita Hills area, who assisted and led the team in the field. We are grateful to Peter Chandler (Melksham, UK) and Trude Magnussen (Oslo, Norway) for comments on an earlier draft of the manuscript.

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